

CNC – Programmer- (Onsite Virginia Beach Convention Center)



COMPETITOR RESOURCE

Haas Automation is a sponsor of the 2024 SkillsUSA CNC Machining Competitions. We are committed to providing materials for Regional and State competitions throughout the United States for the 2024 CNC Machining Competitions.

In addition, we are providing a list of resources to help prepare students to enter the CNC Machining competitions and the workforce of our industry, feeling well-equipped for success. Please see the following pages for resources or visit our website at haascnc.com.

For Regional and State level SkillsUSA testing materials, please contact the SkillsUSA State Director in your state.



Haas Automation, Inc. | 2800 Sturgis Rd. Oxnard, CA 93030

Sponsor of SkillsUSA CNC Competitions

CNC Programmer | CNC 2-Axis Turning | CNC 3-Axis Milling | CNC 5-Axis Milling Programmer

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About the Competition:

Regional and State-level CNC Milling Programmer, CNC 2-Axis Turning, CNC 3-Axis Milling, and State CNC 5-Axis Milling Programmer competitions will test two major skills areas (1) a CNC theory test and (2) CAM programming and Oral Professional Development Assessment.

CNC Theory Test:

The CNC theory test is a set of multiple-choice questions closely related to the CNC subject area of focus for the competition, i.e., milling or turning. Competitors must select the best answer that applies, reading each question carefully before choosing an answer. Contestant numbers must be written on the test in the space provided on each page, or the competitor will receive 0 points.

Programming:

The programming portion of the competition will provide competitors with access to a part drawing, STEP model, and Process Plan. It is the competitor's job to use the provided documents to complete a CAM program. If run, the program would produce a machined part that is in accordance with the Process Plan, collision-free, and accurate to the part drawing provided. The drawing will be complete with multiple views making it easy for competitors to visualize the part and understand its geometry. The Process Plan will provide setup instructions, a sequence of operations, and tool data. Contestant numbers must be used as the name for the CAM file. If this step is missed, the competitor will receive 0 points. Remember, save early, save often.

Competitors will be provided with all testing documents mentioned above, but **competitors must provide the following items to compete successfully.**

- (Required) Laptop or PC with access to CAM software (Mastercam or Autodesk Fusion)
- (Required) Pen or pencil for notes or written calculations
- (Optional) Basic calculator

NOTE: Judges have access to a Theory Test Key and Programming Score Card, which can be used to calculate the appropriate points for the SkillsUSA Regional/State Score Card.



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Recommended Competitor Preparation

Set yourself up for success by committing to continuous learning. Haas Automation, and other supporting partners, offer an array of opportunities for everyone to learn about the principles of CNC machining. Get ahead by preparing yourself as a competitor before and after competitions.

Haas Certification Program

These online courses are designed to provide the basic knowledge necessary to get started as a CNC machine operator or CNC machinist. They introduce basic CNC machine operation, proper machine safety, and fundamental machining processes. For more information and to sign-up for the free online courses, visit: <https://www.learn.haascnc.com>

Haas Programming Workbooks

These programming workbooks provide the basic principles to program Haas Mills and Haas Lathes. Numerous exercises throughout the workbook enable users to build their skills at their own pace. Answer Books are also available. To download, visit the Haas Learning Resources webpage: https://www.haascnc.com/myhaas/Haas_Learning_Resources.htm

Haas Video Library

The Haas Video Library gives you access to thousands of videos recorded specifically to help Haas CNC users everywhere to grow their skills and understanding of CNC machining to maximize their abilities. Access videos directly from the Haas Video Library via the Haas YouTube channel or using the Quick Picklist of the Haas Learning Resources page, which organizes a handful of entry- to advanced-level videos to help get you started. For the complete Video Library, visit: <https://www.haascnc.com/video.html> Or, for the shortened Quick Picklist, visit: https://www.haascnc.com/myhaas/Haas_Learning_Resources.html

CAM Programming Training and Software

Partners Mastercam and Autodesk Fusion provide access to software and video training programs. Please visit the links below for information on accessing software and training resources.

Mastercam Learning Content: <https://my.mastercam.com/hubs/learning/>

Sign up for a free myMastercam account to gain access to free Courses in Core, 2D Mill, 3D Mill, Lathe, Multiaxis, and more.

Free Acoustic Amplifier Project-Based Tutorial: <https://signup.mastercam.com/project-part-series-1-amplifier>

Mastercam Software Access for SkillsUSA: <https://www.mastercam.com/skillsusa/>

Contact Email: education@mastercam.com



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Autodesk is a proud National Partner of SkillsUSA and a member of the Technical Committee for the CNC Competitions at the Regional, State and National levels. Autodesk is excited to be a part of the 2024 CNC Competition and wish all competitors the best of luck!

Autodesk and SkillsUSA:

Information on how Autodesk can support you in SkillsUSA Manufacturing competitions.

<https://www.autodesk.in/campaigns/education/skillsusa>

**If the page doesn't load, please check back soon for updates.*

Download Autodesk Fusion:

Autodesk Fusion is an all-in-one integrated CAD/CAM/CAE software that is **free for students and educators**. Available on Mac, PC, and Chromebook.

<https://www.autodesk.com/campaigns/education/fusion-360>

Autodesk Fusion Learning Resources:

Extend your skills with our free courses, featuring self-paced courses, tutorials, and learning modules.

<https://www.autodesk.com/certification/learn/catalog/product/Fusion%20360>

If you have questions or would like additional support, please reach out to amy.shapiro@autodesk.com

Competitor Instruction:

Theory Test:

Add your contestant number in the space provided. If printed, add the contestant number on each page. For each multiple-choice question, select the best answer that applies. Be sure to read each question carefully before choosing the answer. Write neatly. Make sure your contestant number is on the test before submitting. Questions without an answer receive zero points.

Programming:

Open the STEP model in your CAM software of choice. Save the file using your contestant number in the file name. Use the provided documents (Drawing and Process Plan) to program the model using the information provided (Ex. Stock Setup, Operation Sequence, Tool Data, Feed and Speeds, and WCS). **Save OFTEN**. When done, check the entire program from start to finish, and save. The judged file should resemble a perfect program, which, if run on a machine,




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would produce a machined part that is accurate to the print and collision-free. Submit your completed program via USB flash drive.

 DECIMAL EQUIVALENT CHART .0059 – .0980


Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0059	.97	0.150		.0320	.67	0.813	
.0063	.96	0.160		.0330	.66	0.838	
.0067	.95	0.170		.0350	.65	0.889	
.0071	.94	0.180		.0360	.64	0.914	
.0075	.93	0.191		.0370	.63	0.940	
.0079	.92	0.201		.0380	.62	0.965	
.0083	.91	0.211		.0390	.61	0.991	
.0087	.90	0.221		.0400	.60	1.016	
.0091	.89	0.231		.0410	.59	1.041	
.0095	.88	0.241		.0420	.58	1.067	
.0100	.87	0.254		.0430	.57	1.092	
.0105	.86	0.267		.0465	.56	1.181	
.0110	.85	0.279		.0469	$\frac{3}{64}$	1.191	#0-80
.0115	.84	0.292		.0520	.55	1.321	
.0120	.83	0.305		.0550	.54	1.397	
.0125	.82	0.318		.0595	.53	1.511	#1-64:#1-72
.0130	.81	0.330		.0625	$\frac{1}{16}$	1.588	
.0135	.80	0.343		.0635	.52	1.613	
.0145	.79	0.368		.0670	.51	1.702	
.0156	$\frac{1}{64}$	0.397		.0700	.50	1.778	#2-56:#2-64
.0160	.78	0.406		.0730	.49	1.854	
.0180	.77	0.457		.0760	.48	1.930	
.0200	.76	0.508		.0781	$\frac{5}{64}$	1.984	
.0210	.75	0.533		.0785	.47	1.994	#3-48
.0225	.74	0.572		.0810	.46	2.057	
.0240	.73	0.610		.0820	.45	2.083	#3-56
.0250	.72	0.635		.0860	.44	2.184	
.0260	.71	0.660		.0890	.43	2.261	#4-40
.0280	.70	0.711		.0935	.42	2.375	#4-48
.0292	.69	0.742		.0938	$\frac{3}{32}$	2.381	
.0310	.68	0.787		.0960	.41	2.438	
.0313	$\frac{1}{32}$	0.794		.0980	.40	2.489	

 Tap drill sizes above based on approximately 75% full thread
 Tap # Sizes #0 = .060 #1 = .073 #2 = .086 #3 = .099 #4 = .112
 Tap # x .013 + .060 = Thread # OD

2 MACHINIST'S CNC REFERENCE GUIDE

DECIMAL EQUIVALENT CHART .0995 – .2969 

Decimal Equiv.	Drill Size	mm	Tap Sizes	Decimal Equiv.	Drill Size	mm	Tap Sizes
.0995	.39	2.527		.1875	$\frac{3}{16}$	4.763	#12-32
.1015	.38	2.578	#5-40	.1890	.12	4.801	
.1040	.37	2.642	#5-44	.1910	.11	4.851	
.1065	.36	2.705	#6-32	.1935	.10	4.915	
.1094	$\frac{7}{64}$	2.778		.1960	.9	4.978	
.1100	.35	2.794		.1990	.8	5.055	
.1110	.34	2.819		.2010	.7	5.105	$\frac{1}{4}$ -20
.1130	.33	2.870	#6-40	.2031	$\frac{13}{64}$	5.159	
.1160	.32	2.946		.2040	.6	5.182	
.1200	.31	3.048		.2055	.5	5.220	
.1250	$\frac{1}{8}$	3.175		.2090	.4	5.309	
.1285	.30	3.264		.2130	.3	5.410	$\frac{1}{4}$ -28
.1360	.29	3.454	#6-32:#6-36	.2188	$\frac{7}{32}$	5.556	$\frac{1}{4}$ -32
.1405	.28	3.569		.2210	.2	5.613	
.1406	$\frac{9}{64}$	3.572		.2280	.1	5.791	
.1440	.27	3.658		.2340	A	5.944	
.1470	.26	3.734		.2344	$\frac{15}{64}$	5.953	
.1495	.25	3.797	#10-24	.2380	B	6.045	
.1520	.24	3.861		.2420	C	6.147	
.1540	.23	3.912		.2460	D	6.248	
.1563	$\frac{5}{32}$	3.969		.2500	$\frac{1}{4}$ &E	6.350	
.1570	.22	3.988		.2570	F	6.528	$\frac{5}{16}$ -18
.1590	.21	4.039	#10-32	.2610	G	6.629	
.1610	.20	4.089		.2656	$\frac{17}{64}$	6.747	
.1660	.19	4.216		.2660	H	6.756	
.1695	.18	4.305		.2720	I	6.909	$\frac{5}{16}$ -24
.1719	$\frac{11}{64}$	4.366		.2770	J	7.036	
.1730	.17	4.394		.2810	K	7.137	
.1770	.16	4.496	#12-24	.2813	$\frac{9}{32}$	7.144	$\frac{5}{16}$ -32
.1800	.15	4.572		.2900	L	7.366	
.1820	.14	4.623	#12-28	.2950	M	7.493	
.1850	.13	4.699		.2969	$\frac{19}{64}$	7.541	

 Tap drill sizes above based on approximately 75% full thread
 Tap # Sizes #5 = .125 #6 = .138 #8 = .164 #10 = .190 #12 = .216
 Tap # x .013 + .060 = Thread # OD

MACHINIST'S CNC REFERENCE GUIDE **3**



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DECIMAL EQUIVALENT CHART .3020 – 1.000						
Decimal Equiv.	Drill Size	Tap Sizes	Decimal Equiv.	Drill Size	Tap Sizes	
.3020	N	7.671	.5625	9/16	14.288	5/8-18
.3125	5/16	7.938	.5781	37/64	14.684	5/8-24
.3160	O	8.026	.5938	19/32	15.081	
.3230	P	8.204	.6094	39/64	15.478	1 1/16-12
.3281	21/64	8.334	.6250	5/8	15.875	
.3320	Q	8.433	.6406	41/64	16.272	1 1/16-20, 1 1/16-24
.3390	R	8.611	.6563	21/32	16.669	3/4-10
.3438	11/32	8.731	.6719	43/64	17.066	
.3480	S	8.839	.6875	11/16	17.462	3/4-16
.3580	T	9.093	.7031	45/64	17.859	3/4-20
.3594	23/64	9.128	.7188	23/32	18.256	
.3680	U	9.347	.7344	47/64	18.653	13/16-12
.3750	3/8	9.525	.7500	3/4	19.050	13/16-16
.3770	V	9.576	.7656	49/64	19.447	13/16-20, 7/8-9
.3860	W	9.804	.7813	25/32	19.844	
.3906	25/64	9.922	.7969	51/64	20.241	7/8-14
.3970	X	10.084	.8125	13/16	20.637	
.4040	Y	10.262	.8281	53/64	21.034	7/8-20
.4063	13/32	10.319	.8438	27/32	21.431	
.4130	Z	10.490	.8594	55/64	21.828	15/16-12
.4219	27/64	10.716	.8750	7/8	22.225	15/16-16, 1.0-8
.4375	7/16	11.113	.8906	57/64	22.622	15/16-20
.4531	29/64	11.509	.9063	29/32	23.019	
.4688	15/32	11.906	.9219	59/64	23.416	1.0-12
.4844	31/64	12.303	.9375	15/16	23.813	
.5000	1/2	12.700	.9531	61/64	24.209	1.0-20
.5156	33/64	13.097	.9688	31/32	24.606	
.5313	17/32	13.494	.9844	63/64	25.003	
.5469	35/64	13.891	1.000	1	25.400	

Tap drill sizes above based on approximately 75% full thread.
A decimal equivalent chart can be displayed on a Haas control by pressing the HELP/ CALC button, and then selecting the Drill Table tab. Use the jog handle or cursor keys to scroll through the chart.

MILL AND LATHE FORMULAS	
<p>Cutting Speed (surface feet/min.) SFM = 0.262 x DIA x RPM</p> <p>Revolutions Per Minute RPM = 3.82 x SFM ÷ DIA</p> <p>Feed Rate (in/min.) IPM = FPT x T x RPM</p> <p>Feed Per Revolution FPR = IPM ÷ RPM</p> <p>Feed Per Tooth (in) FPT = IPM ÷ (RPM x T)</p> <p>Metal Removal Rate MRR = W x d x F</p> <p>Converting IPR to IPM IPM = IPR x RPM</p>	<p>Converting IPM to IPR IPR = IPM ÷ RPM</p> <p>Converting SFM to SMPM SMPM = SFM x .3048</p> <p>Converting IPR to MMPR MMPR = IPR x 25.40</p> <p>Distance over Time (in minutes) L = IPM x TCm</p> <p>Time Cutting over Distance (Mill) (minutes) TCm = L ÷ IPM</p> <p>Time Cutting over Distance (Mill) (seconds) TCS = L ÷ IPM x 60</p>
INCH METRIC CONVERSION	
mm x 0.03937 = in.	in. x 25.4 = mm
m x 39.37 = in.	in. x 0.0254 = m
m x 3.2808 = ft	ft x 0.3048 = m
m x 1.0936 = yd	yd x 0.9144 = m
km x 0.621 = mi	mi x 1.6093 = km
Celsius to Fahrenheit (°C x 1.8) + 32 = °F	Fahrenheit to Celsius (°F - 32) ÷ 1.8 = °C



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DRILL POINT DEPTH & COUNTERSINK DIAMETER FORMULAS



To calculate drill tip depth for a chamfer diameter, or drill point depth for a required drilling depth:

Drill Point Angle (DPA)	Factor
60°	0.866 x Dia. = Point Depth
82°	0.575 x Dia. = Point Depth
90°	0.500 x Dia. = Point Depth
118°	0.300 x Dia. = Point Depth
120°	0.288 x Dia. = Point Depth
135°	0.207 x Dia. = Point Depth

Example: To calculate for a 118-degree drill tip depth, multiply the dia. by 0.3
i.e., 0.250 drill diameter x .3 = 0.075 drill tip depth

